

**Remarks**

Currently pending in the application are Claims 1-5, wherein Claims 4 and 5 are currently amended.

In view of the following remarks, Applicant respectfully requests reconsideration by the Examiner, and advancement of the application to allowance.

1. Rejections Under 35 U.S.C. § 112, second paragraph

Claims 4 and 5 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. Claims 4 and 5 have been amended to remove the word "type" from "Mannich-base type hardener."

The definiteness of claim language must be analyzed, not in a vacuum, but in light of: (A) The content of the particular application disclosure; (B) The teachings of the prior art; and (C) The claim interpretation that would be given by one possessing the ordinary level of skill in the pertinent art at the time the invention was made. (MPEP 2173.02). Applicants respectfully assert that one of ordinary skill in the art would know a Mannich-base hardener, JEFFAMINE® D-230 amine; JEFFAMINE® D-400 amine; JEFFAMINE® T-403 amine based on (B) the teachings of the prior art. Applicants have attached two publicly available references with publication dates before the provisional filing date for this application. The first reference is a copy of the relevant parts of a book titled, "Mannich Bases Chemistry and Uses," by Maurilio Tramontini and Luigi Angiolini, 1994 (see Appendix I). This reference teaches Mannich-bases as hardeners on pages 173-175. Applicants have additionally attached a technical bulletin available from Huntsman from 2001 (see Appendix II). On pages 4 and 7 the CAS numbers,

structures, molecular weight and other information regarding JEFFAMINE® D-230 amine; JEFFAMINE® D-400 amine; JEFFAMINE® T-403 amine are disclosed. Applicants conclude that the claims are definite because of teachings of the prior art, therefore, Applicants respectfully request that the rejections to Claims 4 and 5 under 35 U.S.C. § 112, second paragraph, be withdrawn.

2. Rejections Under 35 U.S.C. § 103(a)

Claims 1, 2 and 4 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 4,487,806 issued to Sellstrom et al. ("Sellstrom") in view of U.S. Pat. No. 3,654,370 issued to Yeakey ("Yeakey").

Claims 1, 3 and 5 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 4,178,427 issued to Waddill et al. ("Waddill").

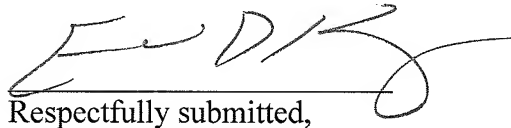
Applicants respectfully traverse these rejections for the following reason. The similarity in this case is predicated on the substitution of an ethyl group in place of a methyl group in one specific place on the polyamines referred to in the references above. There are, however, many other places on these polyamines to make such a substitution. There is no teaching or suggestion in the references nor has the Examiner demonstrated that it would have been obvious to one of ordinary skill in the art to make the substitution of an ethyl group in place of a methyl group at that *particular* position at which Applicants have placed the ethyl substituents so as to enhance the properties of the polyamine. Where "there is no teaching that substitution in certain other spots is beneficial, one who teaches otherwise has made an unobvious contribution to the art." *In re Wagner*, 371 F.2d 877 at 885 (C.C.P.A. 1967). Applicants therefore respectfully request that the rejection to Claims 1-5 under 35 U.S.C. § 103(a) be withdrawn.

**Conclusion**

In view of the foregoing remarks, Applicant respectfully submits that the application is now in condition for allowance, and respectfully requests issuance of a Notice of Allowance directed towards the pending claims.

Should any fees be due in connection with the filing of this document, the Commissioner for Patents is hereby authorized to deduct said fees from Huntsman Corporation Deposit Account No. 08-3442.

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Respectfully submitted,

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Reg. No. 55,344  
Attorney for Applicants

Date:

3-11-08

## Appendix I

CAL

# MANNICH BASES

*Chemistry and Uses*

Maurilio Tramontini  
Luigi Angiolini

3SES



CRC Press

Boca Raton Ann Arbor London Tokyo

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## Introduction

## Chapter I S

### A Aminome

#### A.1 Subs

#### A.2 Amir

#### A.3 Aldel

#### A.4 Prefc

### B Aminome

#### B.1 Reac

#### B.2 Mecl

#### B.3 By-p

### C Synthesis

#### C.1 Cher

#### C.2 Regi

#### C.3 Stere

#### C.4 Synt

#### C.5 Conc

#### C.6 Stere

### D Survey of

#### D.1 CH

#### D.2 XH

## Chapter II

### A Cleavage

#### A.1 Dear

#### A.2 Dear

### B Amino G

#### B.1 Repl

#### B.2 Repl

#### B.3 Repl

### C Reduction

#### C.1 Hyd

#### C.2 Hyd

### D Addition

#### D.1 Reac

#### D.2 Reac

### E Cyclizati

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# Mannich Bases in Macromolecular Chemistry

The present chapter deals with the application of Mannich aminomethylation or Mannich bases to the synthesis and modification of macromolecular compounds. As summarized in Fig. 150, a remarkable number of different combinations exist, as the Mannich reaction enables us (a) to perform polymerizations by using bifunctional substrate and amine as well as (d) to functionalize polymeric derivatives behaving, alternatively, as substrate or amine components of Mannich synthesis. On the other hand, the manifold reactivity of Mannich bases makes it possible (b) to produce polymers by amino group replacement with bifunctional nucleophiles or to polymerize suitable moieties (e.g., double bonds) present in the base. Furthermore (e), macromolecular compounds can be subjected to amino group replacement as well as to various other reactions given by Mannich bases. Finally (c), crosslinked derivatives are obtained from oligomeric or polymeric products through any of the above mentioned methods.

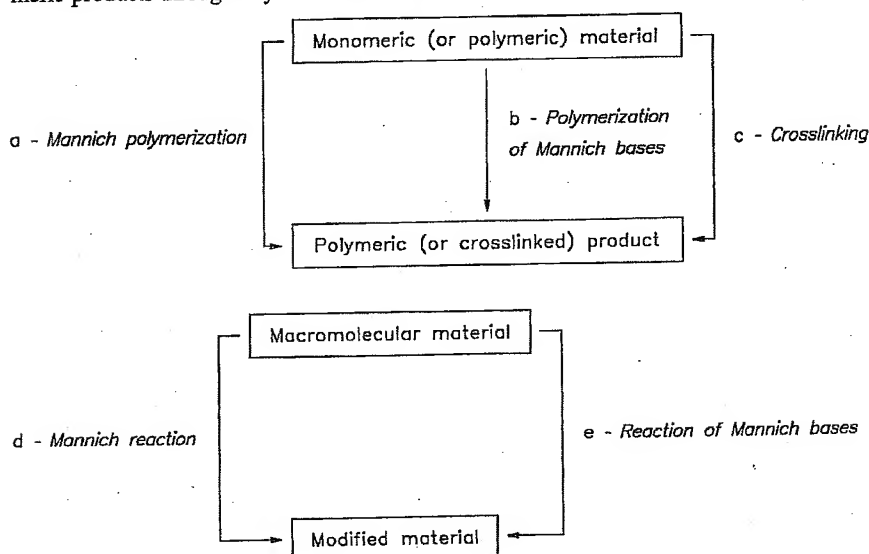


Fig. 150. The chemistry of Mannich bases involved in the synthesis (a-c) and modification (d,e) of macromolecular compounds.

Individual macromolecular derivatives having specific applications in industry are also mentioned in Chap. V, the present chapter being dedicated to the treatment of paths (a)–(c) of Fig. 150. A thorough survey,<sup>1</sup> along with some review papers on particular topics,<sup>2,3</sup> is present in the relevant literature on the subject.

## A Mannich Polymerization

When a Mannich reaction is carried out between a substrate containing at least two active hydrogen atoms and a primary or a bis-secondary amine, a polycondensation takes place with production of a polymeric derivative. The polycondensation can also occur when both an NH group and one active hydrogen atom are present in the same molecule. The reaction product is thus characterized by the presence of the methylene moiety, which is derived from the formaldehyde, and forms the polymer backbone, with the consequent possibility of polymer degradation by deamination or deaminomethylation; both of these reactions are typical of Mannich bases (Chap. II, A).

The first kind of polycondensation follows the scheme shown in Fig. 151, involving monomers of type A-A, B-B (Table 31), with formation of the polymeric products 375 and 376. The monomer mixture generally consists of the usual three components of Mannich synthesis, although in some cases preformed reagents of type  $X-CH_2-N<$ , such as 382 in Table 31, are used.

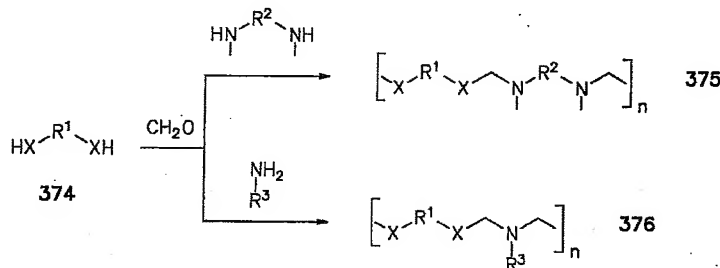


Fig. 151. The Mannich polymerization of monomers of type A-A, B-B.

The two reactive hydrogen atoms of the substrate also may be linked to the same carbon atom, as in the case of alkyl ketones. Other classes of substrates employed in polymerization include phenols, heterocyclic derivatives, etc. Nitrogen-containing substrates, mainly amides and arylamines, are also used. However, as the aromatic ring of arylamines is activated toward electrophilic reactions, products generated by C-amino-methylation of the ring are to be expected along with the polymer formed by N-amino-methylation of the aminic substrate. The amine reagents employed (377–382 in Table 31) are quite varied; piperazine (380) is the most used among bis-amines. Polymeric derivatives having structure 375 are also obtained<sup>18,19</sup> by reaction with primary bis-amines, such as isophorone-diamine, meta-xylylenediamine, etc., in the molar ratio substrate/formaldehyde/amine 1:2:1. Since these last polymeric Mannich bases (e.g., 383) \* contain secondary amino groups, they are successfully employed as hardeners for epoxy resins.<sup>18</sup>

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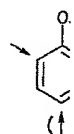
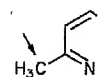
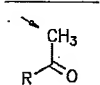
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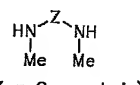
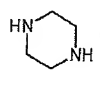
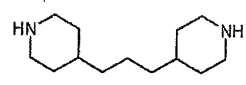
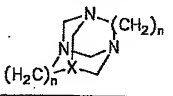




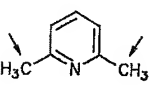
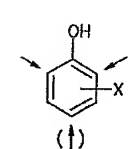
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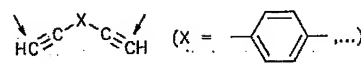
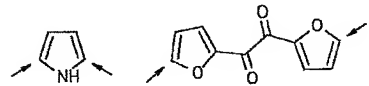
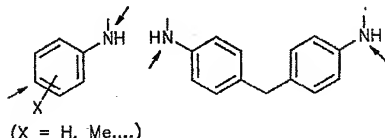
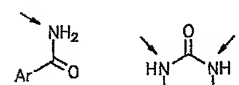
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**Table 31**  
**Three-Component Mannich Polymerization Employing Monomers of Types A-A, B-B, and Formaldehyde (Fig. 151)**

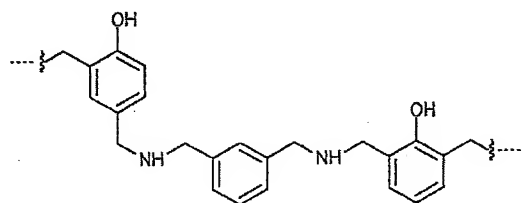
Primary Amines		Bifunctional Amine		
Alkyl-NH <sub>2</sub> (alkyl groups containing NR <sub>2</sub> , OH, COOH, included)	Ar-NH <sub>2</sub>			
377	378			
Bis-Amines				
 (Z = C <sub>0,2-6</sub> chain)				
379	380	381		
Preformed Mannich Reagents				
 (n = 1, 2; X = N, P)	382			
Substrate ( 374 ) <sup>a</sup>	Bifunctional Amine	Polymer	Reference	
  	380, 381 377, 378	375 376	4-6 7,8	
	379	375	9	
	380	375	8	
 (†)	379-381 377, 382	375 376	4,7,10 11-13	

It is finally worth mentioning that guanidine, melamine, and similar derivatives are frequently used as amine reagents or, sometimes, as preformed reagents.<sup>20-22</sup> The above reactions are related to the analogous, even more commonly applied, amidomethylations (Chap. I, A.2) involving urea derivatives; all these compounds have similar chemical features and applications.

Table 31  
(continued)

	380 378	375 376	14,15 15
	380, 381 377	375 376	6,7 7
	380 377	375 376	4,5,7,16 8
	381 382	375 376	8 11,17

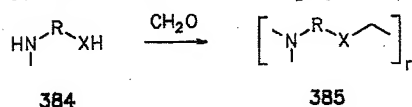
<sup>a</sup> Arrow indicates the most likely position of attack by the reagent.



383

The second kind of polycondensation based on the Mannich reaction includes monomers of type A-B (384, Fig. 152), requiring equimolar amounts of formaldehyde in order to produce the polymeric derivatives 385.

As the possibility of concurrent cyclization (Chap. I, C.4) of monomers 384 has to be avoided for a successful polymerization, the most suitable starting materials are



-R-X- = Arylene moieties

Fig. 152. The Mannich polymerization of monomers of type A-B.

products given by aminophenols or mixtures of different arylamines,<sup>25</sup> have been described.

arylamino derivatives, which undergo C-aminomethylation on the activated site of the aromatic ring. However, when multiple reactive sites are present in the aromatic ring, branched derivatives and even cross-linked products are likely to be produced.<sup>23</sup> Polymers 386, obtained from *p*-amino-benzoic acid<sup>24</sup> as well as analogous

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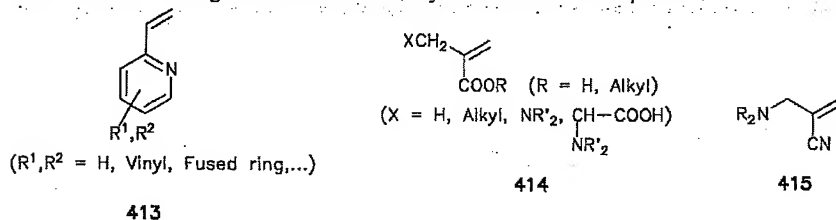
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## B.2 Mannich Bases as Precursors of Monomers

Vinyl,<sup>29,64</sup> acrylic,<sup>65-69</sup> etc.,<sup>71</sup> as well as acrylonitrile<sup>70</sup> monomers **413-415** are readily obtained from Mannich bases. Further examples concerning analogous derivatives are reported in Chap. II, A.2. Deuterated compounds<sup>66,67</sup> are also included among acrylic acid derivatives along with several variously functionalized compounds.



The above monomers are obtained mainly by deamination or deaminodecarboxylation of carboxylic Mannich bases. Acrylic monomers have also been obtained by addition of alkene Mannich bases to acrylonitrile<sup>69</sup> and vinyl monomers by deamination of the Mannich bases of alkylpyridines and alkylquinolines.<sup>29,64</sup>

## C Crosslinked Products from Mannich Bases

The Mannich reaction as well as Mannich bases are frequently involved in the production of crosslinked materials<sup>1</sup> having important applications in industry as resins, coatings, adhesives, etc., as described below in the appropriate chapters on the practical use of Mannich bases. In addition to the inherent complexity of the matter, as far as chemistry and structure of products are concerned, it is necessary to bear in mind that the literature reports, mainly patents, may be rather vague about the chemistry involved in the preparation of the final materials.

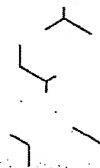
As is well known, two main routes can be adopted for obtaining crosslinked derivatives, as schematically depicted in Fig. 159; these include use of polyfunctional oligomers or monomers (route a) and reaction of high-molecular-weight linear polymers with crosslinking reagents (route b).

Mannich bases can be directly involved as macromolecular components of the above materials, or alternatively, they can participate in the process as catalysts.

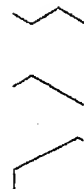
### C.1 Polymerization and Crosslinking of Polyfunctional Oligomers and Monomers

Almost exclusively, step polymerization involving A-A + B-B, or A-B reagents is employed in the process following route a of Fig. 159. As mentioned in connection with Fig. 153, the Mannich base may be the only reacting species yielding the crosslinked product, or it may take part in the reaction as, for example, a comonomer, thus acting as a modifier of the final product. In this context, the main classes of Mannich bases having practical relevance<sup>61</sup> are collected in formulas **416-418**, where the functional groups required for crosslinking are indicated.

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Fig. 159.

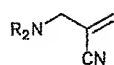
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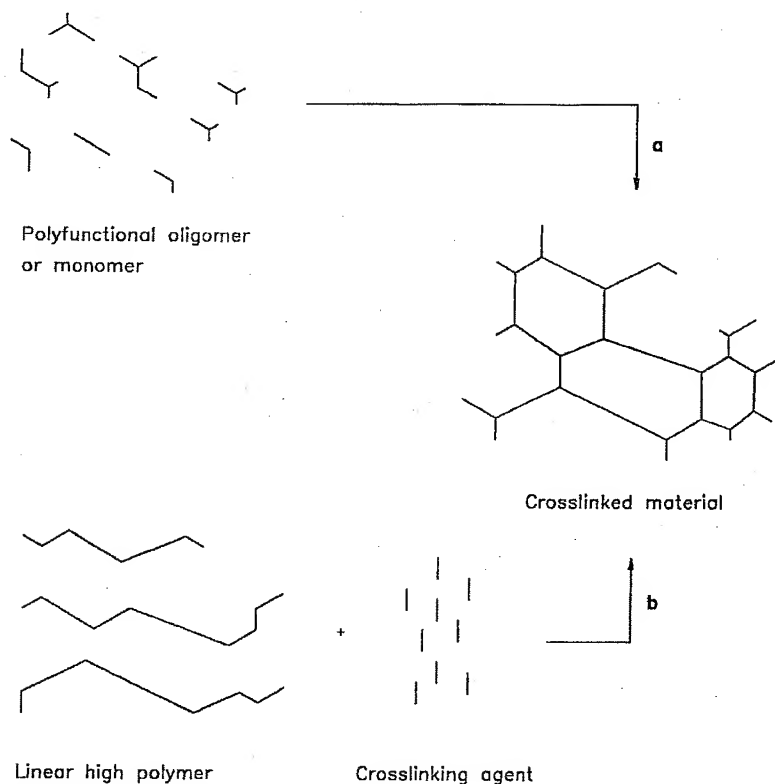
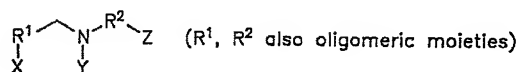


Fig. 159. Routes affording crosslinked products.



416 (X, Z = OH):

- Oligomers for polyurethanes

417 (Y = H; X and/or Z = NH):

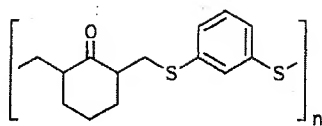
- Reactive hardeners for epoxy resins

418 (R<sup>1</sup>-X = substituted phenol with free ortho or para positions):

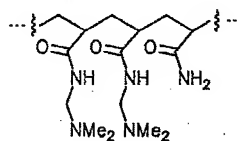
- Hardening of novolacs with urotropine  
- Baking of electrophoretic coatings

Derivatives 416, rich in hydroxy groups, are very good oligomers in the crosslinking of polyurethanes. Phenolic Mannich bases as well as N- and P-Mannich bases are used to this end. The first group of compounds includes mainly Mannich bases of alkanolamines,<sup>40-42</sup> which are treated with epoxides in order to produce hydroxylated polyfunctional oligomers having structure of type 399 (Sec. B.1). N-Mannich bases are

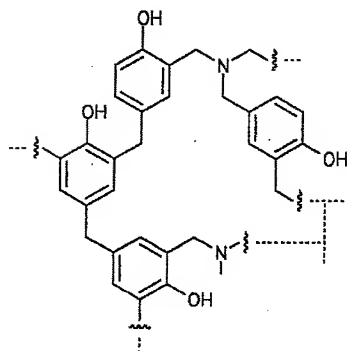




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502



503

Polymeric macromolecules of types V–VII are needed for applications requiring enhanced molecular size (see also Chap. III). Thus, linear polymers of type V are prepared by Mannich polymerization or from bis-Mannich bases by exchange reaction, for example, with bis-thiols, as in the case of poly(ketosulfide) **501**, which is useful as a high-molecular-weight antioxidant in the processing of plastics.<sup>16,17</sup> Macromolecules of type VI are generated by the functionalization of polymers, as shown by **502**, which is obtained by aminomethylation of polyacrylamide and used as flocculant in water treatment.<sup>4,5</sup>

Finally, crosslinked structures of type VII may result from the hardening, for instance, of phenolic resins (**503**) through reaction of novolacs with hexamethylenetetramine,<sup>18</sup> which is a preformed aminomethylating agent (see Table 31, Chap. III).

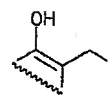
The nature of the chemical moieties present is of course fundamental in determining the possible function of a molecule. Indeed, chemical behavior, such as reactivity, ability to produce ionic species, complexant power, reducing properties, etc., as well as physicochemical features, such as solubility and surface activity, are established by the presence of well-defined groups, as schematically depicted in Table 37; a rigid division between chemical and physicochemical properties exclusively attributable to different chemical moieties can hardly be made, however. Ionogenic groups, for instance, also provide hydrophilicity to the molecule in conjunction with the possibility of ion formation.

Examples of applications determined mainly by chemical properties of the compounds employed are found among resin hardeners **504**,<sup>19</sup> flocculants **505**,<sup>4,20,21</sup> complexants **506**,<sup>22,23</sup> and ionamines **507**,<sup>24,25</sup> while the use of additives for lubricant oils<sup>26</sup> and antistatic agents<sup>27,28</sup> **508–510** is more markedly based on physicochemical behavior.

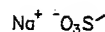
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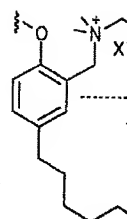
- a.
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508

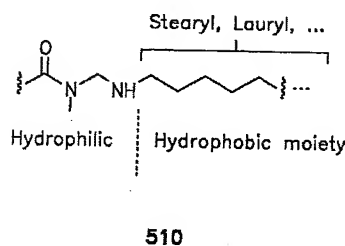
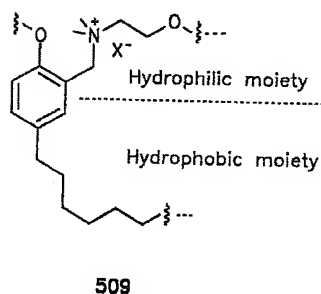
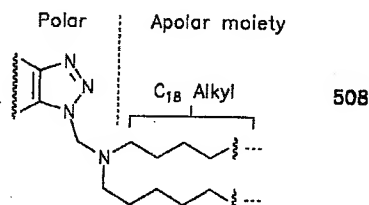
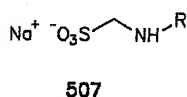
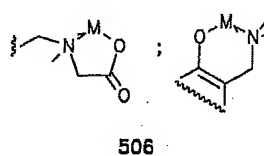
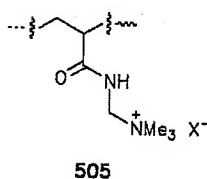
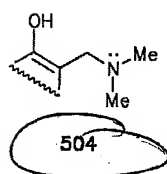
The major one or more substances of the best-suited of replacing a basic analog



Table 37

## Influence of Relevant Chemical Moieties on the Properties of Mannich Bases

Type	Chemical moiety	Affected properties
a.	Basic groups (as in 504)	mainly chemical
b.	Ionogenic groups (as in 505, 507, 509)	
c.	Reactive groups (complexant, hydrolyzable, having reducing power, etc. as in 506, 507)	
d.	Polar-Apolar groups (as in 508 - 510)	mainly physico-chemical
e.	Hydrophilic-Hydrophobic groups (as in 509, 510)	



The major feature of the Mannich reaction, namely, the possibility of introducing one or more amine moieties into a substrate, represents a peculiar method for producing substances possessing basic groups (a, Table 37). This allows a potentially large selection of the best-suited amine (Chap. I, A.2), which can be further widened by the possibility of replacing an amino group by another amino compound (Chap. II, B.2). When non-basic analogous structures are required, the replacement reaction can be carried out with

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nical behavior.

## Appendix II

# Technical Bulletin

## HUNTSMAN

### AMINE APPLICATIONS AND PROPERTIES DATA

#### APPLICATIONS

##### ALKANOLAMINES

**Monoethanolamine (MEA):** A chemical intermediate in the manufacture of cosmetics, surface-active agents, emulsifiers, and plasticizing agents; a gas-scrubbing agent for removal of  $H_2S$  and  $CO_2$  from refinery and natural gas streams, and carbon dioxide from ammonia manufacturing; corrosion inhibitor, metal working fluids.

**Diethanolamine (DEA):** An intermediate in the manufacture of cosmetics; surface-active agents used in household detergents and textiles specialties; insecticides and herbicides; petroleum demulsifiers; as a gas scrubber in refinery and natural gas operations; waxes, polishes, and coatings emulsifiers; soluble oils; metal working fluids; and corrosion inhibitors.

**Triethanolamine (TEA):** An intermediate in the manufacture of surface-active agents used in textile demulsifiers, toilet goods, cement additives, cutting oils, photographic-film developers; corrosion inhibitor; dispersant for dyes, casein, shellac, and rubber latex; sequestering agents; rubber chemical intermediate.

**Dimethylethanolamine (DMEA):** An intermediate in the manufacture of water treating chemicals. A component of water-reducible paints; an intermediate in the preparation of textile chemicals, ion exchange resins, pharmaceuticals, and emulsifying agents; an epoxy curing agent; and a urethane catalyst.

**N-methyldiethanolamine (MDEA):** A gas-treating agent for absorption and removal of  $H_2S$  and  $CO_2$ ; urethane catalyst; textile softener; pH control; an epoxy resin curing agent.

**Monomethylethanolamine (MMEA):** Used in photoresist stripper formulations and as an intermediate in the production of pharmaceuticals, and in general transportation coatings.

**DIGLYCOLAMINE® Agent/DGA® brand 2-(2-aminoethoxy)ethanol:** Removal of  $CO_2$ , COS and  $H_2S$  from hydrogen synthesis gas, refinery gas, and natural gas streams; selective solvent for recovery of aromatics from refinery streams. Other applications include preparation of foam stabilizers, wetting and emulsifying agents, condensation polymers, photoresist strippers, metal working and personal care products.

##### MORPHOLINES

**Morpholine (MOR):** A corrosion inhibitor, especially in steam boiler systems; an emulsifier for cosmetics, rubless waxes, and polishes; a separating agent for volatile amines; an intermediate in the manufacture of optical brighteners; an intermediate for textile lubricants, softening agents, adjuvants, whitening agents, sizing emulsifiers, rubber vulcanization accelerators, antioxidants, surface-active agents, plasticizers, viscosity improvers, insecticides, fumigants, herbicides, dyes, and catalysts.

**N-methylmorpholine (NMM):** Stabilizer for chlorinated hydrocarbons; extraction solvent; preparation of self-polishing waxes, oil emulsions, corrosion inhibitors, water-reducible paints, pharmaceuticals and urethane catalysts.

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Huntsman Corporation

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**N-ethylmorpholine (NEM):** Stabilizer for chlorinated hydrocarbons; extraction solvent; preparation of self-polishing waxes, oil emulsions, corrosion inhibitors, pharmaceuticals, and urethane catalysts.

**N-methylmorpholine oxide, aqueous solution (NMMO):** Can be used to form cellulose solutions from which cellulose films or fibers may be obtained.

### PIPERAZINES

**N-aminoethylpiperazine (AEP):** An epoxy resin curing agent used to formulate epoxy systems for coating, adhesives, sealants, reinforced composites, potting and encapsulation, and tooling compounds.

**Dimethylpiperazine (DMP):** Catalyst for polyether urethane foams; intermediate for cationic surface-active agents.

### SUBSTITUTED PROPYLAMINES

**Dimethylaminopropylamine (DMPA):** Intermediate for hair products, betaine manufacturing, gasoline additives, antistatic agents, agricultural emulsifiers, fabric softeners, asphalt antistripping agents, and dyes; epoxy curing agent.

**Methoxypropylamine (MPA):** Specialty emulsifier intermediate for floor waxes, water treating chemicals, and other products

**Aminopropylmorpholine (APM):** Intermediate for printing dyes, additives for fuels and lube oils, and specialty surfactants.

**Aminopropylmonomethylethanolamine (APMMEA):** Useful in metal working formulations, coatings, epoxy curing, emulsifiers, betaine manufacturing; intermediate for personal care products, adhesives.

### JEFFCAT® TERTIARY AMINES

**N, N-Dimethylcyclohexylamine (DMCHA):** General purpose amine catalyst for urethane foams.

**Pentamethyldiethylenetriamine (PMDETA):** A tertiary amine catalyst for use in the urethane industry.

**Tetramethylbis(aminoethyl)ether:** A general purpose, high efficient blowing catalyst used in urethane flexible foams and rigid packaging foams.

**N,N-dimethyl-2-(2-aminoethoxy)ethanol (DMDGA™ amino alcohol):** A tertiary amino alcohol often used in the urethane industry and metal working.

**Pentamethyldipropylenetriamine:** A catalyst for both the water-isocyanate reaction and the polyol-isocyanate reaction.

**Tetramethyldipropylenetriamine:** A catalyst for both the water-isocyanate reaction and the polyol-isocyanate reaction.

### ETHYLENEAMINES

**Ethyleneamines:** Versatile reactive intermediates used to produce a wide range of chemical products. Ethyleneamine applications include lube and fuel additives, epoxy curing agents, agricultural chemicals, fabric softeners, pharmaceuticals, personal-care products, textile additives, asphalt additives, bleach activators, chelating agents, corrosion inhibitors, drainage aids, elastomeric fibers, fungicides, hydrocarbon purification, mineral processing aids, polyamide resins, rubber processing additives, plastic lubricants, surfactants, and wet-strength resins. They also are used in the manufacture of polyols and urethane catalysts for polyurethane products.

### JEFFAMINE®

#### POLYOXYALKYLENEAMINES

**JEFFAMINE monoamines, diamines, and triamines:** Versatile in their use and tailorable in their structure, these products are used in a variety of chemistries such as epoxy, curatives, polyamides and other polymer derivatives. As epoxy curing agents, they impart low color, reduce viscosity, and increase flexibility, providing cure systems tailored to meet specific requirements. They can be used in preparing polyamide, polyurea, and modified urethane resins; in adhesives, elastomers, and foam formulations; as corrosion inhibitors; in agricultural chemical applications; and as intermediates for textile and paper treating chemicals. Polymeric derivatives may be useful as dispersants in paints, fuels, and lubricants and as viscosity index improvers for lube oils.

### SURFONAMINE®

#### SURFACTANT AMINES

**SURFONAMINE Surfactant Amines:** Chemical intermediates for use in production of pigment modifiers, fuel additives, rheology modifiers, emulsifiers, pressure sensitive adhesives and corrosion inhibitors.

### OUR QUALITY POLICY

*Huntsman Corporation is committed to providing products and services that consistently conform to our customers' requirements. To fulfill this commitment, the employees of Huntsman Corporation are dedicated to "being the best" through continuous improvement. In implementing its quality policy, Huntsman Corporation is committed to the use of statistical methods.*

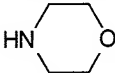
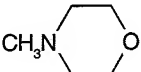
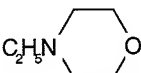
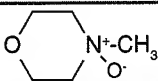
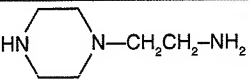
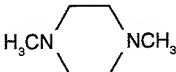
## CAS, EINCS, and MITI Numbers of Huntsman Amines

Amine	CAS	EINCS	ENCS (MITI)
<b>Alkanolamines</b>			
Monoethanolamine (MEA)	141-43-5	205-483-3	Sec. 2 #301
Diethanolamine (DEA)	111-42-2	203-868-0	Sec. 2 #302
Triethanolamine (TEA)	102-71-6	203-49-8	Sec. 2 #308
Dimethylethanolamine (DMEA)	108-01-0	203-542-8	Sec. 2 #297
N-methyldiethanolamine (MDEA)	105-59-9	203-312-7	Sec. 2 #300
Monomethylethanolamine (MMEA)	109-83-1	203-710-0	Sec. 2 #295
DIGLYCOLAMINE® Agent/DGA® brand 2-(2-aminoethoxy)ethanol	929-06-6	213-195-5	Sec. 2 #3202
Aminoethylethanolamine (AEEA)	111-41-1	203-867-5	Sec. 2 #304
<b>Morpholines</b>			
Morpholine (MOR)	110-91-8	203-815-1	Sec. 5 #859
N-methylmorpholine (NMM)	109-02-4	203-640-0	Sec. 5 #860
N-ethylmorpholine (NEM)	100-74-3	202-865-0	Sec. 5 #860
N-methylmorpholine oxide, aqueous solution (NMMO)	7529-22-8	231-391-8	—
<b>Piperazines</b>			
N-aminoethylpiperazine (AEP)	140-31-8	205-411-0	Sec. 5 #961
Dimethylpiperazine (DMP) JEFFCAT®DMP	106-58-1	203-412-0	—
<b>Substituted Propylamines</b>			
Dimethylaminopropylamine (DMAPA)	109-55-7	203-680-9	Sec. 2 #158
Methoxypropylamine (MPA)	5332-73-0	226-241-3	Sec. 2 #385
Aminopropylmorpholine (APM)	123-00-2	204-590-2	Sec. 5 #862
Aminopropylmonomethylethanolamine (APMMEA) XTA-758	41999-70-6	255-615-9	
<b>JEFFCAT® Tertiary Amines</b>			
N,N-Dimethylcyclohexylamine (DMCHA)	98-94-2	202-715-5	Sec. 3 #2274
Pentamethyldiethylenetriamine (PMDETA)	3030-47-5	221-201-1	Sec. 2 #147
Tetramethyl bis(aminoethyl)ether (ZF-20)	3033-62-3	221-220-5	Sec. 2 #390
DMDGA™ N,N-dimethyl-2-(2-aminoethoxy)ethanol (ZR-70)	1704-62-7	216-940-1	Sec. 2 #454
Tetramethyldipropylenetriamine (ZR-50B)	3855-32-1	223-362-3	Sec. 2 #3284
Pentamethyldipropylenetriamine (ZR-40)	6711-48-4	229-761-9	—
Benzyltrimethylamine (BDMA )	103-83-3	203-149-1	3-332

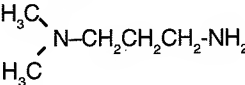
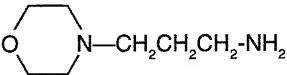
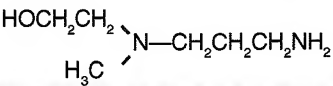
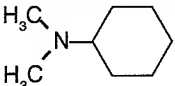
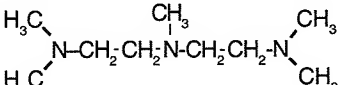
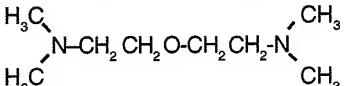
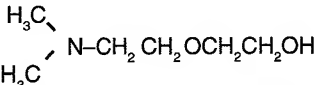
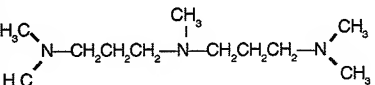
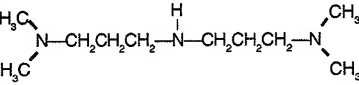
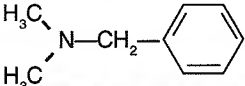
## CAS, EINCS, and MITI Numbers of Huntsman Amines

Amine	CAS	EINCS	ENCS (MITI)
<b>Ethyleneamines</b>			
Ethylenediamine (EDA)	107-15-3	203-486-6	Sec. 2 #150
Diethylenetriamine (DETA)	111-40-0	203-386-54	Sec. 2 #159
Triethylenetetramine (TETA)	112-24-3	203-950-6	Sec. 2 #163
Tetraethylenepentamine (TEPA)	112-57-2	203-986-2	Sec. 2 #162
<b>JEFFAMINE® Polyoxyalkyleneamines</b>			
XTJ-505 (M-600)	83713-01-3	Polymer	—
XTJ-506 (M-1000)	83713-01-3	Polymer	—
XTJ-507 (M-2005)	83713-01-3	Polymer	—
M-2070	83713-01-3	Polymer	—
D-230	9046-10-0	Polymer	Sec. 7 #324
<del>D-400</del>	9046-10-0	Polymer	Sec. 7 #324
D-2000	9046-10-0	Polymer	Sec. 7 #324
XTJ-510 (D-4000)	9046-10-0	Polymer	Sec. 7 #324
XTJ-500 (ED-600)	65605-36-9	Polymer	—
XTJ-501 (ED-900)	65605-36-9	Polymer	—
XTJ-502 (ED-2003)	65605-36-9	Polymer	—
XTJ-504 (EDR-148)	929-59-9	213-203-6	Sec. 2 #312
HK-511	194673-87-5	—	—
T-403	39423-51-3	Polymer	Sec. 7 #328
XTJ-509 (T-3000)	64852-22-8	Polymer	—
T-5000	64852-22-8	Polymer	—
<b>SURFONAMINE® Surfactant Amines</b>			
ML-300 Chemical intermediate	—	—	—
MNPA-1000	118270-87-4	Polymer	—

## Structures and Properties of Huntsman Amines

Amine	Structure	Boiling Point °C	Mol. Wt.	Flash Point TCC °C	Vapor Pressure 20°C mm Hg	pKa
<b>Alkanolamines</b>						
Monoethanolamine (MEA)	$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{OH}$	170.5 <sup>a</sup>	61.08	95 <sup>b</sup>	<1	—
Diethanolamine (DEA)	$\text{HN} \begin{array}{l} \diagup \text{CH}_2\text{CH}_2\text{OH} \\ \diagdown \text{CH}_2\text{CH}_2\text{OH} \end{array}$	269 <sup>a</sup>	105.14	154 <sup>b</sup>	<0.01	—
Triethanolamine (TEA)	$\text{N} \begin{array}{l} \diagup \text{CH}_2\text{CH}_2\text{OH} \\ \diagdown \text{CH}_2\text{CH}_2\text{OH} \\ \text{CH}_2\text{CH}_2\text{OH} \end{array}$	360 <sup>a</sup>	149.19	201 <sup>b</sup>	<0.01	—
Dimethylethanolamine (DMEA)	$\text{H}_3\text{C} \begin{array}{l} \diagup \text{N}-\text{CH}_2\text{CH}_2\text{OH} \\ \diagdown \text{H}_3\text{C} \end{array}$	134.6	89.14	105 <sup>c</sup>	<0.1 <sup>d</sup>	10.3
N-methyldiethanolamine (MDEA)	$\text{H}_3\text{C}-\text{N} \begin{array}{l} \diagup \text{CH}_2\text{CH}_2\text{OH} \\ \diagdown \text{CH}_2\text{CH}_2\text{OH} \end{array}$	247.3	119.1	101 <sup>b</sup>	<0.01	—
Monomethylethanolamine (MMEA)	$\text{H}_3\text{C} \begin{array}{l} \diagup \text{N}-\text{CH}_2\text{CH}_2\text{OH} \\ \diagdown \text{H} \end{array}$	—	75.1	71.1 <sup>b</sup>	0.50	—
DIGLYCOLAMINE® Agent/DGA® brand 2-(2-aminoethoxy)ethanol	$\text{H}_2\text{N}-\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OH}$	221 <sup>a</sup>	101.14	124 <sup>b</sup>	<0.01	9.5
Aminoethylethanolamine (AEEA)	$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_2-\text{CH}_2-\text{OH}$	243	104.2	>149	<0.01	4.5 <sup>s</sup>
<b>Morpholines</b>						
Morpholine (MOR)		128.3 <sup>a</sup>	87.12	35	7.2	8.45 5.64 <sup>8</sup>
N-methylmorpholine (NMM)		115.6	101.15	61 <sup>c</sup>	18	7.5
N-ethylmorpholine (NEM)		138.3 <sup>a</sup>	115.18	90 <sup>c</sup>	5.2	7.8
M-methylmorpholine oxide, aqueous solution (NMMO)		118.5 <sup>b</sup>	117.2	—	—	—
<b>Piperazines</b>						
N-aminoethylpiperazine (AEP)		222.0	128.8	>99	<0.01	4.4 <sup>s</sup>
Dimethylpiperazine (DMP) JEFFCAT® DMP		131	114.2	72 <sup>c</sup>	11 <sup>i</sup>	8.2, 4.1

## Structures and Properties of Huntsman Amines

Amine	Structure	Boiling Point °C	Mol. Wt.	Flash Point TCC °C	Vapor Pressure 20°C mm Hg	pKa
<b>Substituted Propylamines</b>						
Dimethylaminopropylamine (DMAPA)		134.9 <sup>a</sup>	102.18	29	5.3	3.4 <sup>B</sup> 5.3 <sup>B</sup>
Methoxypropylamine (MPA)	$\text{CH}_3\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}_2$	118.7 <sup>a</sup>	89.1	30 <sup>c</sup>	5.7	3.9 <sup>B</sup>
Aminopropylmorpholine (APM)		224.1 <sup>a</sup>	144.22	88 <sup>c</sup>	0.05	10.0
Aminopropylmonomethyl-ethanolamine (APMMEA) XTA-758		—	132	128	—	—
<b>JEFFCAT® Tertiary Amines</b>						
N,N-Dimethylcyclohexylamine (DMCHA)		160	127.2	40 <sup>b</sup>	2.1	10.0
Pentamethyldiethylenetriamine (PMDETA)		201	173.3	83.3 <sup>b</sup>	<1	9.1 8.0 2.4
Tetramethylbis(aminoethyl)ether (ZF-20)		189	160.3	69	<1	10.1, 7.6
DMDGA™ N,N-dimethyl-2(2-aminoethoxy)ethanol (ZR-70)		201	133.2	93	0.06	9.1
Pentamethyldipropylenetriamine (ZR-40)		227	201.4	92 <sup>b</sup>	<1	9.7 8.4 7.4
Tetramethyldipropylenetriamine (ZR-50B)		222	187.3	190 <sup>b</sup>	<1	9.9 8.5 7.2
Benzyl dimethylamine (BDMA)		180	135.2	54	1.3	—

### Ethyleneamines

Ethylenediamine (EDA)	$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}_2$	116.9	60.1	43	9.34	4.1 <sup>B</sup>
Diethylenetriamine (DETA)	$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_2-\text{CH}_2-\text{NH}_2$	206.7	103.1	102	0.084	4.1 <sup>B</sup>
Triethylenetetramine (TETA)	$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_2-\text{CH}_2-\text{NH}_2$ <sup>j</sup>	276.5	151 <sup>f</sup>	118	<0.01	4.2 <sup>B</sup>
Tetraethylenepentamine (TEPA)	$\text{H}_2\text{N}-(\text{CH}_2-\text{CH}_2-\text{NH})_3-\text{CH}_2-\text{CH}_2-\text{NH}_2$ <sup>i</sup>	332	200 <sup>f</sup>	>177	<0.01	4.2 <sup>B</sup>

## Structures and Properties of Huntsman Amines

Amine	Structure	Boiling Point °C	Mol. Wt.	Flash Point TCC °C	Vapor Pressure 20°C mm Hg	pKa
JEFFAMINE® Polyoxyalkyleneamine						
XTJ-505 (M-600)	$\text{CH}_3-[\text{OCH}_2\text{CH}(\text{R})]_X-[\text{OCH}_2\text{CH}(\text{CH}_3)]_Y-\text{NH}_2$ R=H, CH <sub>3</sub>	—	600 <sup>f</sup>	265 <sup>b,c</sup>	—	—
XTJ-506 (M-1000)		—	1000 <sup>f</sup>	208 <sup>b,c</sup>	—	—
XTJ-507 (M-2005)		—	2000 <sup>f</sup>	208 <sup>b,c</sup>	—	—
M-2070		—	2000 <sup>f</sup>	243.3 <sup>b</sup>	—	—
D-230	$\text{NH}_2\text{CH}(\text{CH}_3)\text{CH}_2-[\text{OCH}_2\text{CH}(\text{CH}_3)]_X-\text{NH}_2$	—	230 <sup>f</sup>	121 <sup>b</sup>	1/101, 10/133	9.46
D-400		—	400 <sup>f</sup>	163 <sup>b</sup>	1/165, 10/193	9.51
D-2000		—	2000 <sup>f</sup>	186 <sup>b</sup>	0.93/235,	8.65
XTJ-510 (D-4000)	$\text{NH}_2\text{CH}(\text{CH}_3)\text{CH}_2-[\text{OCH}(\text{CH}_3)\text{CH}_2]_X-[\text{OCH}_2\text{CH}_2]_Y-[\text{OCH}_2\text{CH}(\text{CH}_3)]_Z-\text{NH}_2$	—	4000 <sup>f</sup>	213 <sup>b</sup>	—	—
XTJ-500 (ED-600)		—	600 <sup>f</sup>	160 <sup>b</sup>	—	—
XTJ-501 (ED-900)		—	900 <sup>f</sup>	134 <sup>b</sup>	—	—
XTJ-502 (ED-2003)		—	2000 <sup>f</sup>	260 <sup>b</sup>	—	—
XTJ-504 (EDR-148)		—	148	265 <sup>b,c</sup>	—	—
HK-511	$\text{NH}_2\text{CH}(\text{CH}_3)\text{CH}_2-(\text{OCH}_2\text{CH}_2)_2-\text{OCH}_2\text{CH}(\text{CH}_3)\text{NH}_2^j$	253 <sup>n</sup>	225 <sup>f</sup>	138 <sup>b</sup>	1 <sup>l</sup> ,10 <sup>m</sup>	—
T-403	$\begin{array}{c} \text{CH}_2-[\text{OCH}_2\text{CH}(\text{CH}_3)]_X\text{NH}_2 \\   \\ \text{CH}_3\text{CH}_2\text{CCH}_2-[\text{OCH}_2\text{CH}(\text{CH}_3)]_Y\text{NH}_2 \\   \\ \text{CH}_2-[\text{OCH}_2\text{CH}(\text{CH}_3)]_Z\text{NH}_2 \end{array}$	—	440 <sup>f</sup>	196 <sup>b</sup>	1/181, 5/207	9.23
XTJ-509 (T-3000)	$\begin{array}{c} \text{CH}_2-[\text{OCH}_2\text{CH}(\text{CH}_3)]_X-\text{NH}_2 \\   \\ \text{CH}_2-[\text{OCH}_2\text{CH}(\text{CH}_3)]_Y-\text{NH}_2 \\   \\ \text{CH}_2-[\text{OCH}_2\text{CH}(\text{CH}_3)]_Z-\text{NH}_2 \end{array}$	—	3000 <sup>f</sup>	235 <sup>b</sup>	—	—
T-5000		—	5000 <sup>f</sup>	210 <sup>b</sup>	—	—
SURFONAMINE® Surfactant Amines						
ML-300 Chemical intermediate	$\text{CH}_3(\text{CH}_2)_{12}-\text{OCH}_2\text{CH}(\text{CH}_3)-\text{OCH}_2\text{CH}(\text{CH}_3)\text{NH}_2$	>350	325	355 <sup>e</sup>	15.4 <sup>k</sup>	—
MNPA-1000	$\text{C}_6\text{H}_5-\text{C}_6\text{H}_4-\text{O}-(\text{CH}_2\text{CH}(\text{CH}_3))_{12.5}-\text{OCH}_2\text{CH}(\text{CH}_3)\text{NH}_2$	—	1004	380 <sup>e</sup>	—	—

<sup>a</sup> At 760mm Hg

<sup>d</sup> At 100°F

<sup>g</sup> pK<sub>b</sub>

<sup>j</sup> primary component

<sup>m</sup> At 139°C

<sup>b</sup> PMCC

<sup>e</sup> COC

<sup>h</sup> As 60% aqueous solution

<sup>k</sup> At 205°C

<sup>n</sup> IBP

<sup>c</sup> °F

<sup>f</sup> Approximate

<sup>i</sup> At 70°F

<sup>l</sup> At 95°C

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24-hour emergency line in Port Neches, Texas:  
409-722-8381

## **OUR PRODUCT SAFETY POLICY**

It is the product safety policy of Huntsman Corporation to provide our customers with information on the safe handling and use of our products. The Material Safety Data Sheet (MSDS) should always be read and understood thoroughly before handling the product, and adequate safety procedures should be followed. Information on the toxicity, environmental, and industrial hygiene aspects of our products may be found in the MSDS.